EDISON'S LIGHT.

The Great Inventor's Triumph in Electric Illumination.

A SCRAP OF PAPER.

It Makes a Light, Without Gas or Flame, Cheaper Than Oil.

TRANSFORMED IN THE FURNACE.

Complete Details of the Perfected Carbon Lamp.

FIFTEEN MONTHS OF TOIL.

Story of His Tireless Experiments with Lamps, Burners and Generators.

SUCCESS IN A COTTON THREAD.

The Wizard's Byplay, with Bodily Pain and Gold "Tailings."

HISTORY OF ELECTRIC LIGHTING.

The near approach of the first public exhibition of Edison's long looked for electric light, announced to take place on New Year's Eve at Menlo Park, on which occasion that place will be illuminated with the new light, has revived public interest in the great inventor's work, and throughout the civilized world scientists and people generally are anxiously awaiting the result. From the beginning of his experiments in electric lighting to the present time Mr. Edison has kept his laboratory guardedly closed, and no authoritative account (except that published in the HERALD some months ago relating to his first patent) of any of the important steps of his progress has been made public—a course of procedure the inventor found absolutely necessary for his own protection. The HERALD is now, however, enabled to present to its readers a full and accurate account of his work from its inception to its completion.

A LIGHTED PAPER.

Edison's electric light, incredible as it may appear, is produced from a little piece of paper—a tiny strip of paper that a breath would blow away. Through this little strip of paper is passed an electric current, and the result is a bright, beautiful light, like the mellow sunset of an Italian autumn.

"But paper instantly burns, even under the trifling heat of a tallow candle!" exclaims the sceptic, "and how, then, can it withstand the fierce heat of an electric current?" Very true, but Edison makes the little piece of paper more infusible than platinum, more durable than granite. And this involves no complicated process. The paper is merely baked in an oven until all its elements have passed away except its carbon framework. The latter is then placed in a glass globe connected with the wires leading to the electricity producing machine, and the air exhausted from the globe. Then the apparatus is ready to give out a light that produces no deleterious gases, no smoke, no offensive odors—a light without flame, without danger, requiring no matches to ignite, giving out but little heat, vitiating no air, and free from all flickering; a light that is a little globe of sunshine, a veritable Aladdin's lamp. And this light, the inventor claims, can be produced cheaper than that from the cheapest oil. Were it not for the phonograph, the quadruplex telegraph, the telephone and the various other remarkable productions of the great inventor the world might well hesitate to accept his assurance that such a beneficent result had been obtained, but, as it is, his past achievements in science are sufficient guarantee that his claims are not without foundation, even though for months past the press of Europe and America has teemed with dissertations and expositions from learned scientists ridiculing Edison and showing that it was impossible for him to achieve that which he has undertaken.

HIS FIRST ATTENTION TO ELECTRIC LIGHTING.

When Edison began his experiments in September, 1878, he had just returned from the inspiring scenery of the Rocky Mountains, where he had been enjoying a little recreation after several months of hard labor. He was ripe for fields and enterprises new. A visit to a Connecticut factory where an electric light was used concentrated his thoughts on the subject of lighting by electricity, and he determined to attack the problem. Previous to this time, although he had roamed broadcast over the domain of electricity, wresting from it, as is well known, many of its hidden secrets, Edison had scarcely thought of the subtle fluid in connection with practical illumination. Now, however, he bent all his energies on the subject, and was soon deep in the bewildering intricacies of subdivision, magneto currents, resistance laws and the various other branches going to make up a system of lighting by electricity. The task before the young inventor was divisible into two parts.

First—The producing of a pure, steady and reliable light from electricity; and

Second—Producing it so cheaply that it could compete with gas for general illumination.

HE CHOOSES INCANDESCENCE.

Of the two systems before him—viz., voltaic arc and the incandescence system, Edison chose the latter as his field of operations. Prominent among the difficulties incident to incandescent lighting, it will be remembered, was the liability of the platinum (when that metal was used) to melt under the intense heat of the electric current, and the liability of the carbon, when that was employed, to gradually become dissipated under the combined action of gases and the electric current.

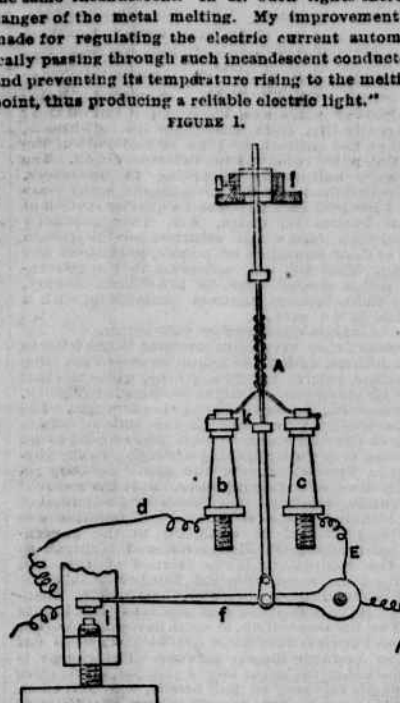
THE PLATINUM LIGHT.

As between platinum and carbon as the substance to be made incandescent, Edison took up platinum and devoted first his attention to the obtaining of some device to prevent the platinum from melting under the intense heat of the electric current. An ingenious and simple contrivance met the requirement. He arranged a small lever, about three inches long, so that the expansion of the platinum (caused by the heat) beyond a certain degree would close it, such closing making a new passage for the electric current and cutting it off from the incandescent platinum. When the latter contracted, as it did the moment the heat was lessened, the lever returned to its normal position and allowed the electric current to again pass through the platinum. By this device the inventor hoped to be able to keep the incandescent platinum always below its melting point. The contrivance is described in his first patent as follows:—

THE FIRST LIGHT.

"Electric lights have been produced by a coil or strip of platinum or other metal that requires a high temperature to melt, the electric current rendering the same incandescent. In all such lights there is danger of the metal melting. My improvement is made for regulating the electric current automatically passing through such incandescent conductor, and preventing its temperature rising to the melting point, thus producing a reliable electric light."

FIGURE 1.



"Fig. 1 shows one form of the device. The incandescent metal is in the form of a double spiral A, the two ends terminating upon the posts b, c, to which the conductors d, E, are connected. A circuit closing lever, f, is introduced in the electric circuit, the points of contact being at i, and there is a platina, or similar wire, k, connected with the lever, f, to the headpiece or other support, l. The current from a magneto machine is connected with the wires E and d. The current then flows from E to the post, c, thence around the platinum spiral to b, and is carried off by the wire, d. Now, when the rod, k, of platinum becomes heated to too great intensity its expansion closes the lever, f, and the current then passes from E, through f, and not through the spiral at all. In this way the lever cuts off the current every time the heat becomes too intense."

Numerous other devices of a similar character were tried and for a while they all worked satisfactorily, but the inventor finally discovered that the constant expansion of the platinum rod k and its pressure upon the lever f bent it so that it became unreliable and it was, therefore, abandoned.

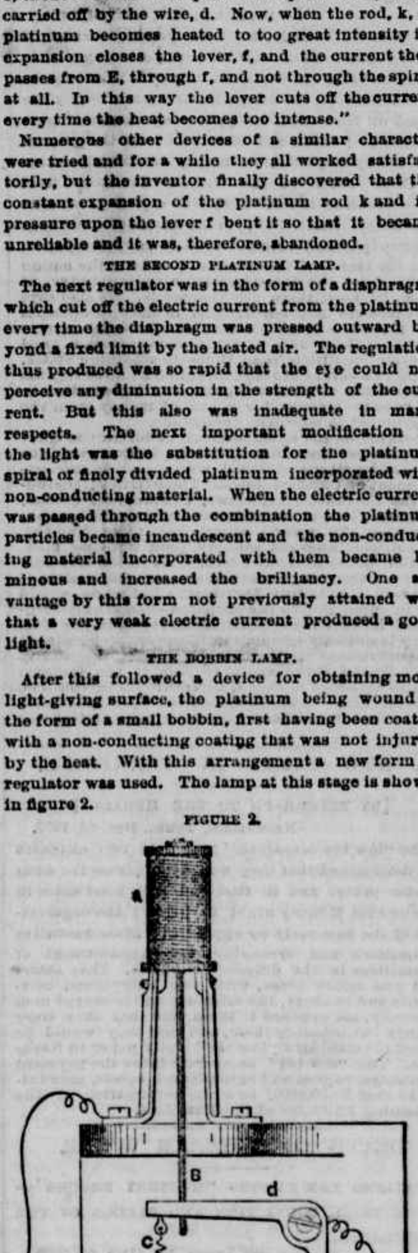
THE SECOND PLATINUM LAMP.

The next regulator was in the form of a diaphragm, which cut off the electric current from the platinum every time the diaphragm was pressed outward beyond a fixed limit by the heated air. The regulation thus produced was so rapid that the eye could not perceive any diminution in the strength of the current. But this also was inadequate in many respects. The next important modification in the light was the substitution for the platinum spiral of finely divided platinum incorporated with non-conducting material. When the electric current was passed through the combination the platinum particles became incandescent and the non-conducting material incorporated with them became luminous and increased the brilliancy. One advantage by this form not previously attained was that a very weak electric current produced a good light.

THE BOBBIN LAMP.

After this followed a device for obtaining more light-giving surface, the platinum being wound in the form of a small bobbin, first having been coated with a non-conducting coating that was not injured by the heat. With this arrangement a new form of regulator was used. The lamp at this stage is shown in figure 2.

FIGURE 2.



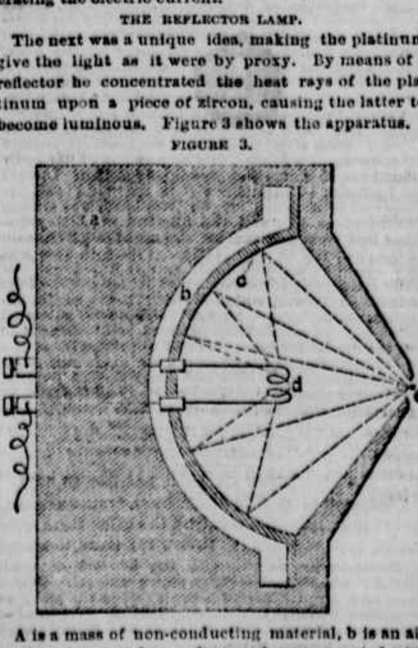
A is the incandescent bobbin, between the coils of which is a coating of magnesia. The top of the bobbin has a metallic cap connected to the lever, d. A spring, C, draws the rod, B, downward with considerable pressure, and this, of course, places pressure on the top of the bobbin, thus keeping the wire in contact with the upper end of the coil. The bobbin, A, expands as a whole by the heat and draws the rod, B, upward. This brings the lever attached upward and allows the lever, E, to come in contact with the screw, f, permitting the current to find a passage other than that afforded by the incandescent material.

The inventor next followed with a new regulator and a meter for measuring the amount of electricity used; also an automatic switch connecting the regulator with the line leading to the machine for generating the electric current.

THE REFLECTOR LAMP.

The next was a unique idea, making the platinum give the light as it were by proxy. By means of a reflector he concentrated the heat rays of the platinum upon a piece of zircon, causing the latter to become luminous. Figure 3 shows the apparatus.

FIGURE 3.

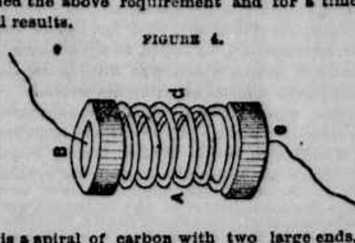


A is a mass of non-conducting material, b is an air space, c is a polished reflector of copper coated with gold, d is a platinum-iridium spiral, which becomes heated by the passage of the electric current through it. E is a thin piece of zircon that receives the heat rays thrown off by the reflector, C, which heat rays bring up the zircon, E, to vivid incandesence, making it give out a light much more brilliant than the light of the platinum spiral, C. With this form Mr. Edison tried numerous experiments, and from time to time made many alterations and improvements, but eventually the apparatus was placed in the category of non-successes.

ANOTHER SPIRAL.

Realizing from the first the necessity of the light giving substance offering much resistance to the passage of the electric current—a necessity in extensive subdivision of the light—the inventor throughout his experiments kept a close watch for substances and forms that gave suitable resistances. In figure 4 is shown a form of lamp disconnected from the regulating apparatus, which largely embodied the above requirement and for a time gave good results.

FIGURE 4.

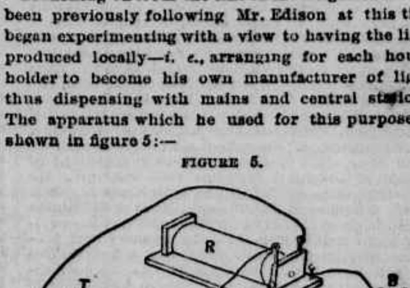


A is a spiral of carbon with two large ends, B, e, connecting with the wires leading to the machine for generating the current. This device was tried for several weeks, but did not, as a whole, give satisfaction.

EVERY MAN HIS OWN ELECTRIC LIGHTER.

Branching off from the line of investigation he had been previously following Mr. Edison at this time began experimenting with a view to having the light produced locally—*i. e.*, arranging for each householder to become his own manufacturer of light, thus dispensing with mains and central stations. The apparatus which he used for this purpose is shown in figure 5:—

FIGURE 5.



R is an induction coil such as are used by peripatetic showmen at fairs and other places when they give electric shocks to inquiring sightseers at so much per shock. It is operated by two cells of battery, B, and wires lead from it to the glass tubing, T, from which the air has previously been extracted, and the passage of the electric current through the tubing gives out a light. This plan is analogous to what is known as the Geisler tube arrangement, the difference being in the form of the tube and the extreme smallness of the bore and also in the degree of vacuum produced. Mr. Edison succeeded by this arrangement in obtaining a light of several candle power with a moderately powerful induction coil. The light, however, was not the one sought after so persistently by the inventor, and so it took its place in that part of his laboratory occupied by inventions not in use.

OSMIUM-IRIDIUM.

Once more Mr. Edison made a departure. He moulded powdered metallic oxides in the form of sticks and subjected them to a very high temperature. In this connection he obtained very fine results from the native alloy of osmium-iridium called iridosmine, which alloy he used in the form of a powder enclosed in a tube of zircon. The electric current passing through the same brought it to a beautiful incandescence.

CARBON AND PLATINUM.

The inventor's next important move was the adoption of carbon in connection with platinum as the substances to be made incandescent. He caused a slender rod of carbon to rest upon another of platinum, the inferiority of contact between the two at their point of meeting producing a resistance to the passage of the electric current and causing the carbon to become highly incandescent, while the platinum attained only a dull red heat. The carbon rod was kept pressing upon the platinum by a weight ingeniously arranged. A dozen or more forms of this lamp were made; but, after all, the inventor was obliged to return to platinum as the substance most suitable, all things considered, for being made incandescent. For two months he worked at platinum day and night, only to find that platinum, as he had been using it, was entirely worthless for incandescent lighting. To many experimenters this would have proved a discouragement perhaps fatal, but it had the effect only of increasing Edison's determination.

THE CRACKS IN PLATINUM.

After scores of new experiments he arrived at the true causes of the defects and hastened to apply the remedy. I have found, he writes, that when wires or sheets of platinum, iridium or other metallic conductors of electricity that fuse at a high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured, and under the microscope there are revealed myriads of cracks in various directions, many of which reach nearly to the centre of the wire. I have also discovered that, contrary to the received notion, platinum or platinum and iridium alloy loses weight when exposed to the heat of a candle; that even heated air causes it to lose weight; that the loss is so great a hydrogen flame is tinged green. After a time the metal falls to pieces; hence wire or sheets of platinum or platinum and iridium alloy as now known in commerce are useless for giving light by incandescence—

First—Because the loss of weight makes it expensive and unreliable and causes the burner to be rapidly destroyed.

Second—Because its electrical resistance changes by loss in weight, and its light-giving power for the total surface is greatly reduced by the cracks or ruptures.

The melting point also is determined by the weakest spot of the metal.

PLATINUM IN VACUO.

By my invention or discovery I am able to prevent the deterioration of the platinum or its alloys by cutting off or intercepting the atmospheric action. A spiral wire or other forms of platinum is placed in a glass tube or bulb, with the wire near its ends passing through and sealed in the glass, and the air is exhausted from the glass. The platinum wires of the spiral are then connected to a magneto-electric machine or battery, the current of which can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150 degrees Fahrenheit. It is then allowed to remain at this temperature for ten or fifteen minutes. While thus heated both the air and gases confined in the metal are expelled by the heat or withdrawn by the vacuum action.

While this air or the gases are passing out of the metal the mercury pump is kept continually working.

After the expiration of about fifteen minutes the current passing through the metal is augmented so that its temperature will be about 300 deg. Fahrenheit, and it is allowed to remain at this temperature for another ten or fifteen minutes.

The mercury pump is to be worked continuously and the temperature of the spiral raised at intervals of ten or fifteen minutes until it attains vivid incandescence and the glass is contracted where it has passed to the pump and melted together.

BRILLIANT RESULTS.

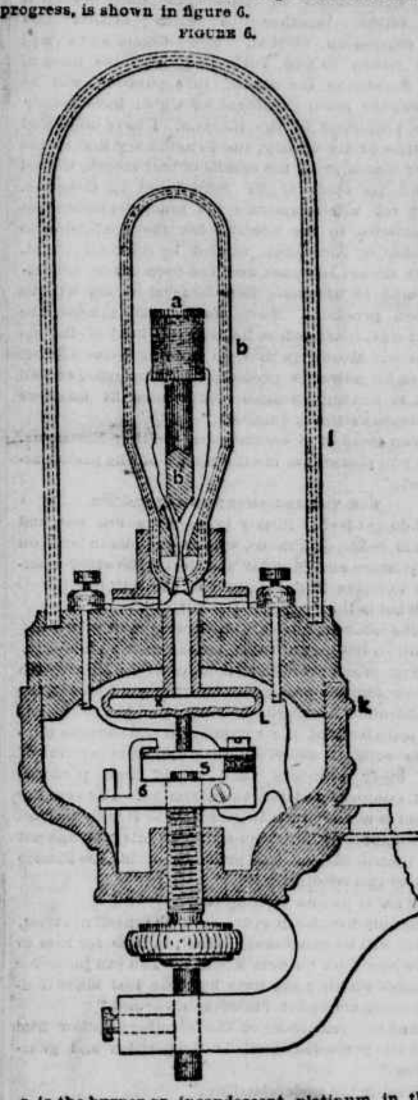
The wire is now in a perfect vacuum and in a state heretofore unknown, for it may have its temperature raised to a most dazzling incandescence, emitting a light of twenty-five standard candles, whereas before treatment the same radiating surface gave a light of only about three standard candles. The wires after being thus free from gases are found to have a polish exceeding that of silver and obtainable by no other means. No cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and the most delicate balance fails to show any loss of weight in the wire even after it is burning for many hours continuously. I have further discovered that if an alloy of platinum and iridium is coated with the oxide of magnesia and subjected to the vacuum process described, a combination takes place between the metal and the oxide, giving the former remarkable properties. With a spiral having a radiating surface of 3-16 of an inch light equal to that given by forty standard candles may be obtained, whereas the same spiral, not coated by my process, would melt before giving a light of four candles. The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory. A spiral made of this wire is elastic and springy when at high incandescence. I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equalling that of platinum in the open air. Carbon sticks also may be freed from air in this manner and be brought to a temperature where the carbon becomes pasty and on cooling it is homogeneous and hard.

THE FIRST PLATINUM VACCUM LAMP.

About this time another truth dawned upon the inventor—namely, that economy in the production of light from incandescence demanded that the incandescent substance should offer a very great resistance to the passage of the electric current. Concerning this the inventor writes:—"It is essential to reverse the present practice of having lamps of but one or two ohms (electrical units) resistance and construct lamps which, when giving their proper light, shall have at least two hundred ohms resistance."

The lamp, as it stood at this stage of the inventor's progress, is shown in figure 6.

FIGURE 6.



a is the burner or incandescent platinum in the shape of a bobbin supported within the vacuum tube, b, by a rod, b', of the same material as the bobbin. The vacuum tube, b, is sustained by the case, k, and around said tube, b, is a glass globe, l. Within the case, k, is a flexible metallic aneroid chamber, L, that opens into the glass case, l, so that the air, when expanded by heat, can pass into the aneroid chamber and give motion to the flexible diaphragm, x, and parts connected therewith. When the current circulating around the bobbin, a, becomes too intense and heats the latter too highly the air within the glass case, l, is expanded and bulges downward by the diaphragm, x, and the pin thereon pressing upon the spring, 5, and separating said spring from the block, 6, breaks the circuit to the burner. The temperature within the globe, l, lowers immediately and the parts return to their normal position, closing the circuit through the burner to 5 and 6. This opening and closing of the circuit is but momentary, and, therefore, the uniform brilliancy of the light is not affected and there is no danger of the burner becoming too highly heated.

PERFECTING THE MACHINERY.

The lamp, after these latter improvements, was in quite a satisfactory condition, and the inventor contemplated with much gratification the near conclusion of his labors. One by one he had overcome the many difficulties that lay in his path. He had brought up platinum as a substance for illumination from a state of comparative worthlessness to one well nigh perfection. He had succeeded, by a curious combination and improvement in air pumps, in obtaining a vacuum of nearly one millionth of an atmosphere, and he had perfected a generator or electricity producing machine (for all the time he had been working at lamps he was also experimenting in magneto-electric machines) that gave out some ninety per cent in electricity of the energy it received from the driving engine. In a word, all the serious obstacles toward the success of incandescent electric lighting, he believed, had melted away, and there remained but a comparatively few minor details to be arranged before his laboratory was to be thrown open for public inspection and the light given to the world for better or for worse.

A GREAT DISCOVERY.

There occurred, however, at this juncture a discovery that materially changed the system and gave a rapid stride toward the perfect electric lamp. Sitting one night in his laboratory reflecting on some of the unfinished details, Edison began abstractedly rolling between his fingers a piece of compressed lampblack mixed with tar for use in his telephone. For several minutes his thoughts continued far away, his fingers in the meantime mechanically rolling out the little piece of tarred lampblack until it had become a slender filament. Happening to glance at it the idea occurred to him that it might give good result as a burner if made incandescent. A few minutes later the experiment was tried, and, to the inventor's gratification, satisfactory, although not surprising results were obtained. Further experiments were made, with altered forms and composition of the substance, each experiment demonstrating that at last the inventor was upon the right track.

A COTTON THREAD.

A spool of cotton thread lay on the table in the laboratory. The inventor cut off a small piece, put it in a groove between two clamps of iron and placed the latter in the furnace. The satisfactory light obtained from the tarred lampblack had convinced him that filaments of carbon of a texture not previously used in electric lighting were the hidden agents to make a thorough success of incandescent lighting, and it was with this view that he sought to test the carbon remains of a cotton thread. At the expiration of an hour he removed the iron mould containing the thread from the furnace and took out the delicate carbon framework of the thread—all that was left of it after its fiery ordeal. This slender filament he placed in a globe and connected it with the wires leading to the machine generating the electric current. Then he extracted the air from the globe and turned on the electricity.

Presto! a beautiful light greeted his eyes. He turns on more current expecting the fragile filament instantly to fuse; but no, the only change is a more brilliant light. He turns on more current, and still more, but the delicate thread remains entire. Then, with characteristic impetuosity and wondering and marvelling at the strength of the little filament, he turns on the full power of his machine and eagerly watches the consequence. For a minute or more the tender thread seems to struggle with the intense heat passing through it—heat that would melt the diamond itself—then at last it succumbs and all is darkness. The powerful current had broken it in twain, but not before it had emitted a light of several gas jets. Eagerly the inventor hastened to examine under the microscope this curious filament, apparently so delicate, but in reality much more infusible than platinum, so long considered one of the most infusible of metals. The microscope showed the surface of the filament to be highly polished and its parts interwoven with each other.

THE PAPER LIGHT.

It was also noticed that the filament had obtained a remarkable degree of hardness compared with its fragile character before it was subjected to the action of the current. Night and day, with scarcely rest enough to eat a hearty meal or catch a brief repose, the inventor kept up his experiments, and from carbonizing pieces of thread he went to splinters of wood, straw, paper and many other substances never before used for that purpose. The results of his experiments showed that the substance best adapted for carbonization and the giving out of incandescent light, was paper preferably thick like card board, but giving good results even when very thin. The beautiful character of the illumination and the steadiness, reliability and non-fusibility of the carbon filament were not the only elements incident to the new discovery that brought joy to the heart of Edison. There was a further element—not the less necessary because of its being hidden—the element of a proper and uniform resistance to the passage of the electric current.

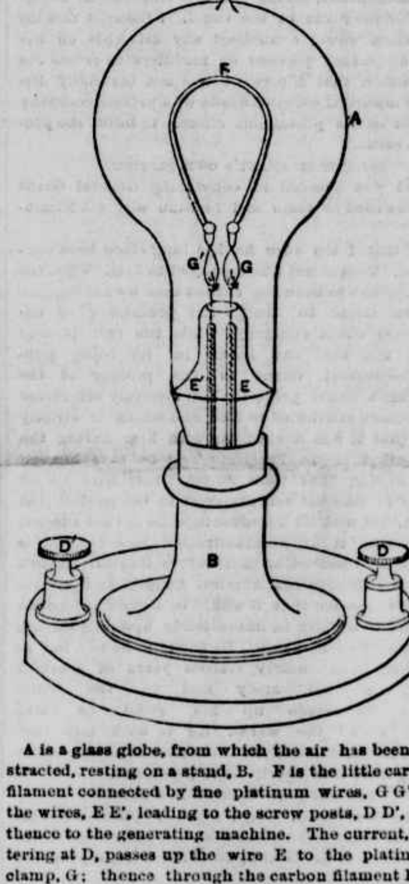
The inventor's efforts to obtain this element had been by far the most laborious of any in the history of his work from the time he undertook the task, and without it absolute success to electric incandescent illumination could not be predicated, even though all the other necessary properties were present in the fullest degree.

Passing over the scores of experiments made since the discovery that the carbon framework of a little piece of paper or thread was the best substance possible for incandescent lighting, we come to consider the way in which the same is prepared at the present time in the laboratory.

MAKING THE PAPER CARBON.

With a suitable punch there is cut from a piece of "Bristol" cardboard a strip of the same in the form of a miniature horseshoe, about two inches in length and one-eighth of an inch in width. A number of these strips are laid flatwise in a wrought iron mould about the size of the hand and separated from each other by tissue paper. The mould is then covered and placed in an oven, where it is gradually raised to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the paper to pass away. The mould is then placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually. On opening the mould the charred remains of the little horseshoe cardboard are found. It must be taken out with the greatest care, else it will fall to pieces. After being removed from the mould it is placed in a little globe and attached to the wires leading to the generating machine. The globe is then connected with an air pump, and the latter is at once set to work extracting the air. After the air has been extracted the globe is sealed, and the lamp is ready for use. Figure 7 shows the lamp complete:—

THE PERFECTED LAMP—FIGURE 7.



A is a glass globe, from which the air has been abstracted, resting on a stand, B. F is the little carbon filament connected by fine platinum wires, G G', to the wires, E E', leading to the screw posts, D D', and thence to the generating machine. The current, entering at D, passes up the wire E to the platinum clamp, G; thence through the carbon filament F to G', down the wire E' to the screw post D'; thence to the generating machine. It will be noticed, by reference to the complete lamp in figure 7, that it has no complex regulating apparatus, such as characterized the inventor's earlier labors. All the work he did in regulators was practically wasted, for he has lately realized that they were not at all necessary—no more so than a fifth wheel is to a coach.

REGULATED AT THE MAIN, LIKE GAS—CHEAP.

He finds that the electricity can be regulated with entire reliability at the central station, just as the pressure of gas is now regulated. By his system of connecting the wires the extinguishment of certain of the burners affects the others no more than the extinguishment of the same number of gas burners affects those drawing the supply from the same mains. The simplicity of the completed lamp seems certainly to have arrived at the highest point, and Edison asserts that it is scarcely possible to simplify it more. The entire cost of constructing them is not more than twenty-five cents.

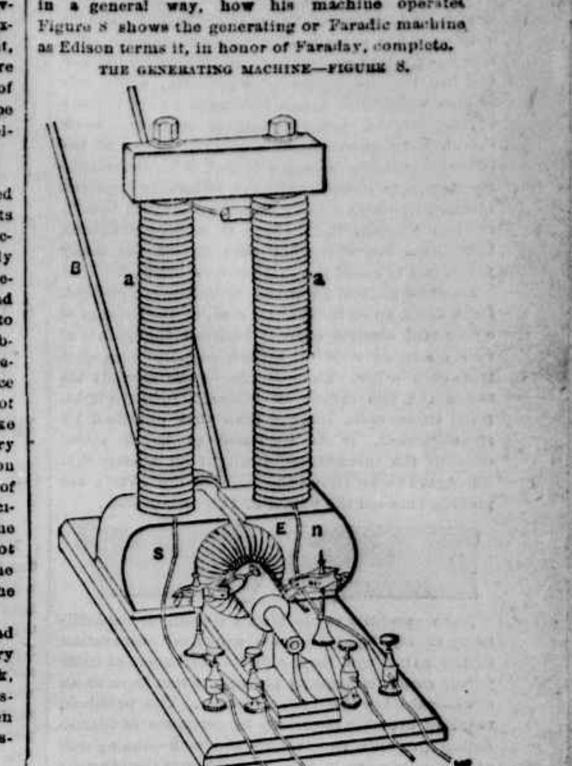
EASY METAMORPHOSIS.

The lamp shown in figure 7 is a table lamp. For chandeliers it would consist of only the vacuum globe and the carbon filament attached to the chandelier and connected to the wires leading to the generating machine in a central station, perhaps a half mile away, the wires being run through the gas pipes, so that in reality the only change necessary to turn a gas jet into an electric lamp is to run the wires through the gas pipe, take off the jet and screw the electric lamp in the latter's place. Although the plans have been fully consummated for general illumination the outline of the probable system to be adopted is the locating of a central station in large cities in such a manner that each station will supply an area of about one-third of a mile. In each station there will be, it is contemplated, one or two engines of immense power, which will drive several generating machines, each generating machine supplying about fifty lamps.

THE GENERATING MACHINE.

Mr. Edison's first experiments in machines for generating the electric current did not meet with success. His primal apparatus was in the form of a large tuning fork, constructed in such a way that its ends vibrated with great rapidity before the poles of a large magnet. These vibrations could be produced with comparatively little power. Several weeks of practice proved, however, that the machine was not practical, and it was laid aside. Then followed a number of other forms, leading up gradually to the one at present used. Bearing in mind the principle common to all magneto-electric machines—viz., that the current is produced by the rotation of magnets near each other—it will not be difficult to understand, in a general way, how his machine operates. Figure 8 shows the generating or Faradic machine as Edison terms it, in honor of Faraday, complete.

THE GENERATING MACHINE—FIGURE 8.



a a are two upright iron columns, three feet high and eight inches in diameter, wound with coarse wire and resting upon the base, n and s, which form its magnetic poles. This part of the apparatus is called the field of force magnet. Fixed on an axle, so as to freely revolve between the poles n and s, is a cylindrical armature of wood, e, wound parallel to its axes with fine iron wire. When this cylinder or armature is made to revolve rapidly between the magnetic poles n and s, by means of the belt B, driven by an engine (not shown in the cut), there is generated in the wire surrounding the armature e strong currents of electricity, which are carried off by the wires, W W, to the electric lamps.

A DOMESTIC MOTOR.

By constructing the machine in the form shown in figure 9 there is obtained an electric motor capable of performing light work, such as running sewing machines and pumping water. It forms part of the inventor's system and may be used either with or without the electric light. To run an ordinary sewing machine it requires only as much electricity as is necessary to give out one electric light of the strength of a common gas jet. To put it in operation on a sewing machine the housewife has merely to attach it by a little belt at A with the wheel of the sewing machine, and turn on the electricity by touching a little knob conveniently attached. The cost is the same as if she was burning one electric light.

THE ELECTROMETER.

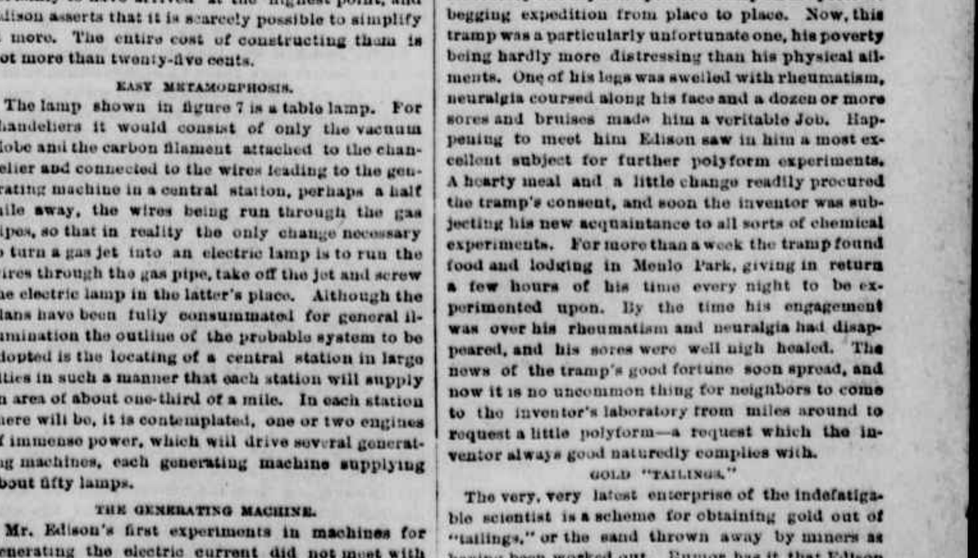
The apparatus for measuring the amount of electricity used by each householder is a simple contrivance consisting of an electrolytic cell and a small coil of wire, appropriately arranged in a box, the latter being of about half the size of an ordinary gas meter, and like a gas meter it can be placed in any part of the house. The measurement is obtained by the deposit of copper particles on a little plate in the electrolytic cell, such deposit being caused by the electric current passing through the cell. At the end of any period, say one month, the plate is taken by the inspector to the central office, where the copper deposit is weighed and the amount of electricity consumed determined by a simple calculation.

In addition to the various parts of the system above described, there are a number of other details, not so important to be sure as those of which sketches have been given, but nevertheless essential to make up the complete plan of economical electrical illumination. A description of these latter will not be attempted, as a proper understanding of them involves a technical knowledge of the laws of electricity. The entire system embraces an amount of work so extensive that one naturally wonders how a single man in such a brief space of time as fifteen months could possibly have planned and perfected it all. And surprise becomes greater when it is considered that during this period Edison found time to make other inventions. A sextuplex telegraph, or apparatus for sending six messages on one telegraph wire in opposite directions simultaneously, saw life during the progress of the electric light, patents for the same having only just been issued. Several new and important improvements in his chalk telephone, by which the efficiency of that invention is greatly increased, also attest his industry and versatility of genius.

POLYFORM.

But perhaps the latter quality is more strikingly exhibited in his polyform or preparation by which he is enabled to bid defiance to sick headaches, neuralgia and other nervous diseases, and to make himself largely independent of physicians in times of ailment. The polyform grew out of necessity. Being considerably afflicted with neuralgia and obtaining no relief from his physician, Edison set about becoming his own doctor. His chemical laboratory, one of the most complete in the United States, furnished him an ample field from which to draw. Experiment followed experiment, the inventor becom-

THE DOMESTIC MOTOR—FIGURE 9.



ing more determined in proportion as his neuralgia grew more painful. At last he obtained a combination of chemicals, a slight application of which to the face immediately relieved his pain. Gratified at his success, but hardly yet convinced, he tried the preparation on others similarly afflicted and with equally satisfactory results.

"IN CORPORE VILI."

About this time there happened to stroll into the laboratory one day a dilapidated tramp on his periodic begging expedition from place to place. Now, this tramp was a particularly unfortunate one, his poverty being hardly more distressing than his physical ailments. One of his legs was swelled with rheumatism, neuralgia coursed along his face and a dozen or more sores and bruises made him a veritable Job. Happening to meet him Edison saw in him a most excellent subject for further polyform experiments. A hearty meal and a little change readily procured the tramp's consent, and soon the inventor was subjecting his new acquaintance to all sorts of chemical experiments. For more than a week the tramp found food and lodging in Menlo Park, giving in return a few hours of his time every night to be experimented upon. By the time his engagement was over his rheumatism and neuralgia had disappeared, and his sores were well nigh healed. The news of the tramp's good fortune soon spread, and now it is no uncommon thing for neighbors to come to the inventor's laboratory from miles around to request a little polyform—a request which the inventor always good naturedly complies with.

GOLD "TAILINGS."

The very, very latest enterprise of the indefatigable scientist is a scheme for obtaining gold out of "tailings," or the sand thrown away by miners as having been worked out. Rumor has it that Edison has succeeded in obtaining a chemical preparation which will take from $200 to $300 per ton out of "tailings" from which the present processes can obtain nothing. The matter, however, is as yet a profound laboratory secret.

ELECTRIC LIGHTING BEFORE EDISON.

Among its other properties electricity has that of developing heat. A substance through which an electric current is made to flow becomes heated to a degree proportioned first to the strength of the current, and second, to the size and character of the